A Comparison of Ground Based Lightning Networks: Earth Networks Total Lightning, National Lightning Detection Network, and Lightning Mapping Arrays

Tiffany Meyer[1,2], Matthew Elliott[1,2], Kristin Calhoun[1,3], Jonathan Kurtz[4]

[1]University of Oklahoma/CIMMS [2]NOAA/NWS/WDTB [3]NOAA/OAR/NSSL [4]NOAA/NWS/WFO OUN

1. INTRODUCTION/BACKGROUND

Sudden increases in total lightning (ie: lightning jump) have been shown to be well correlated with the onset of severe weather (Schultz 2009). This project compares ENTLN to NLDN and LMAs to determine the strengths and weaknesses.

Lightning Mapping Array (LMA):
•Best total lightning (IC and CG) detection network in the US
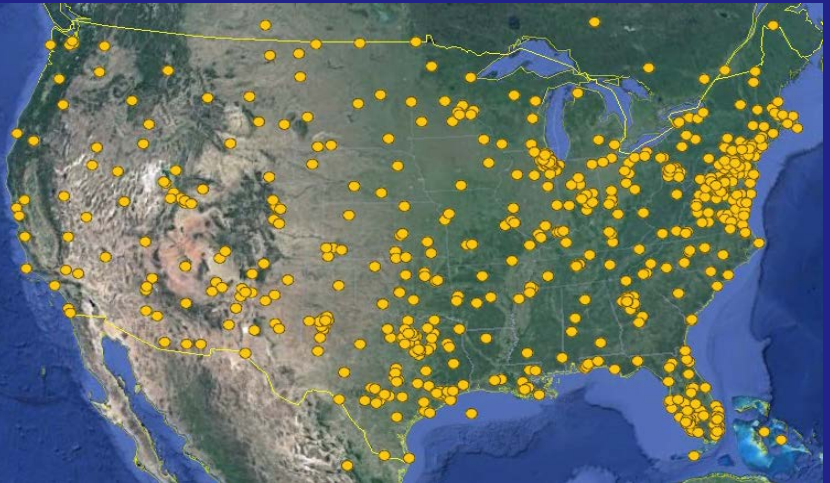•3D as a function of time
•In AWIPS I and AWIPS II (limited offices)
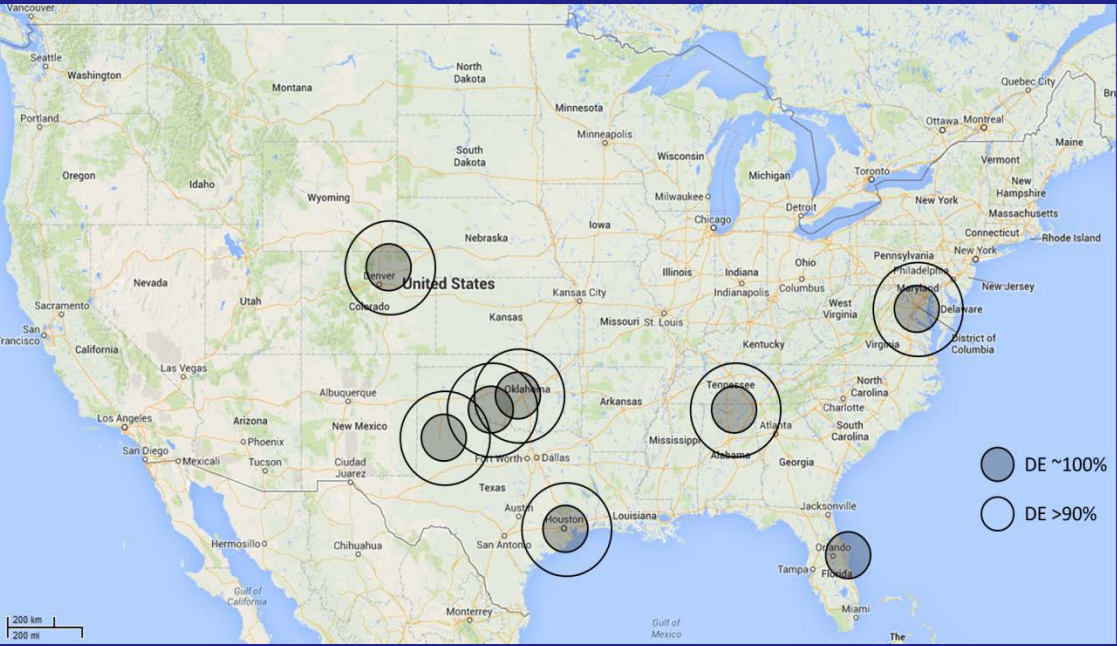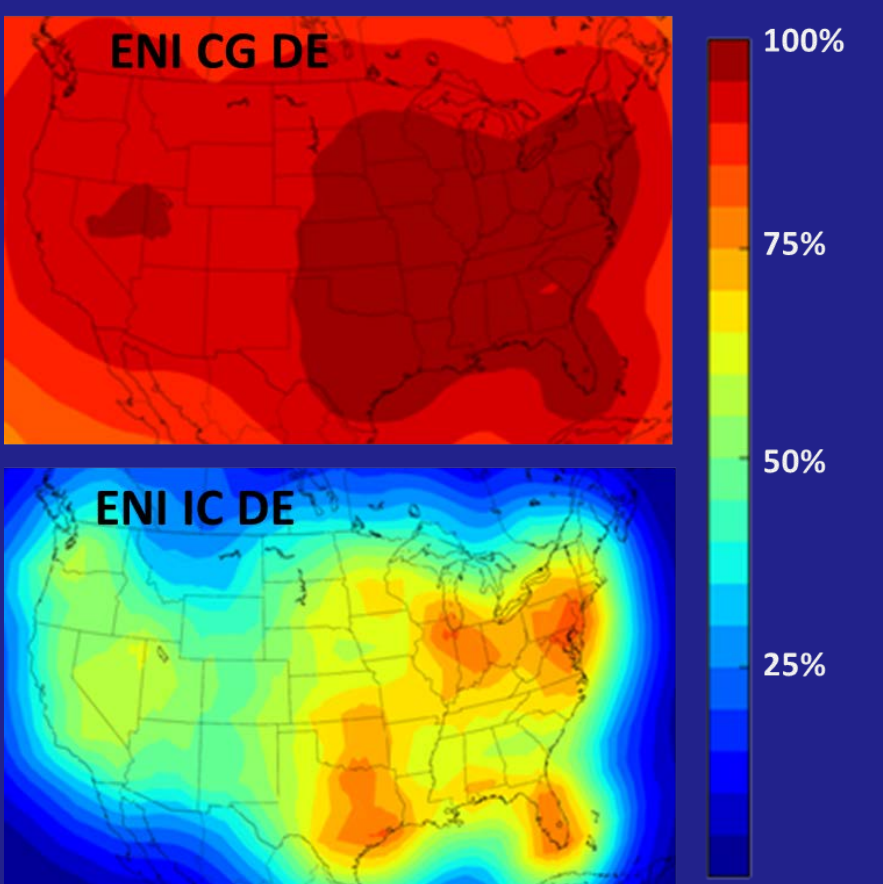
National Lightning Detection Network (NLDN)
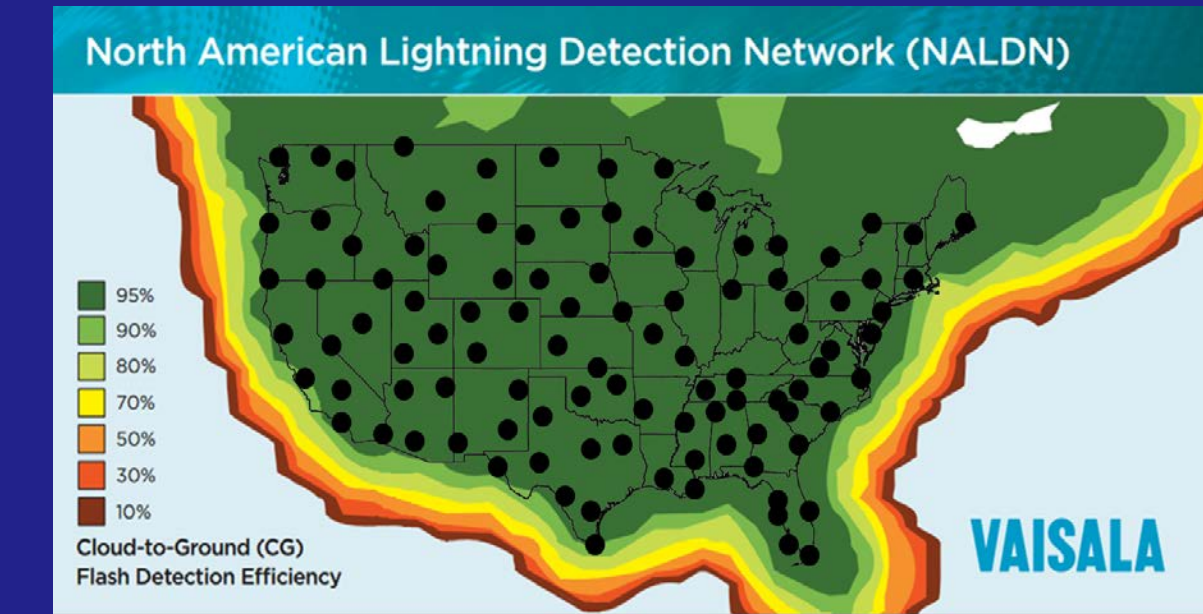
•Detects mainly CG lightning
•Sensors recently upgraded: 50% IC detection
•In AWIPS I and AWIPS II

Earth Networks Total Lightning Network (ENI)

•Detects total lightning (IC and CG)
•Only viewable through website in IE

2. DEFINITIONS

Intra-cloud (IC): lightning discharge between clouds or within same cloud
Cloud-to-ground (CG): lightning discharge between the cloud and the ground

ENI Flash: Pulses grouped together within 700 ms and 10 km (unpublished)

NLDN Flash: Pulses grouped together within 500 ms and 10 km (max duration of 10 sec and 15 pulses) (Cummins et al. 1998)

LMA Flash: VHF sources grouped together within 500 ms and 3 km (max duration of 3 sec) (MacGorman et al. 2008)
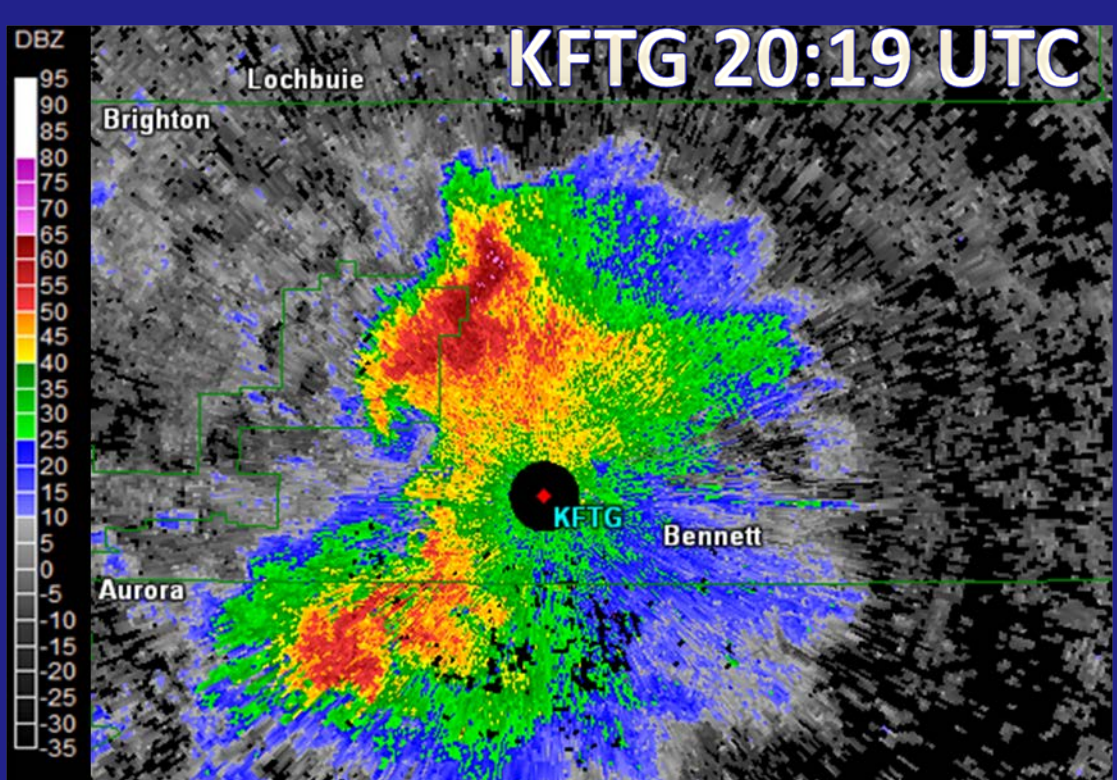
Combined lightning flash over DC with representations of:
•LMA sources (small dots)
•ENI IC/CG pulses (green circle)
•NLDN CG pulses (red X)

Note: This is just a representation of what would be expected, real ENI and NLDN data was not used
(Photo adapted from Scott Rudlosky)

ENI CG vs NLDN CG 6.18.2013 (CO)

ENI Flash vs LMA Flash 6.18.2013 (CO)
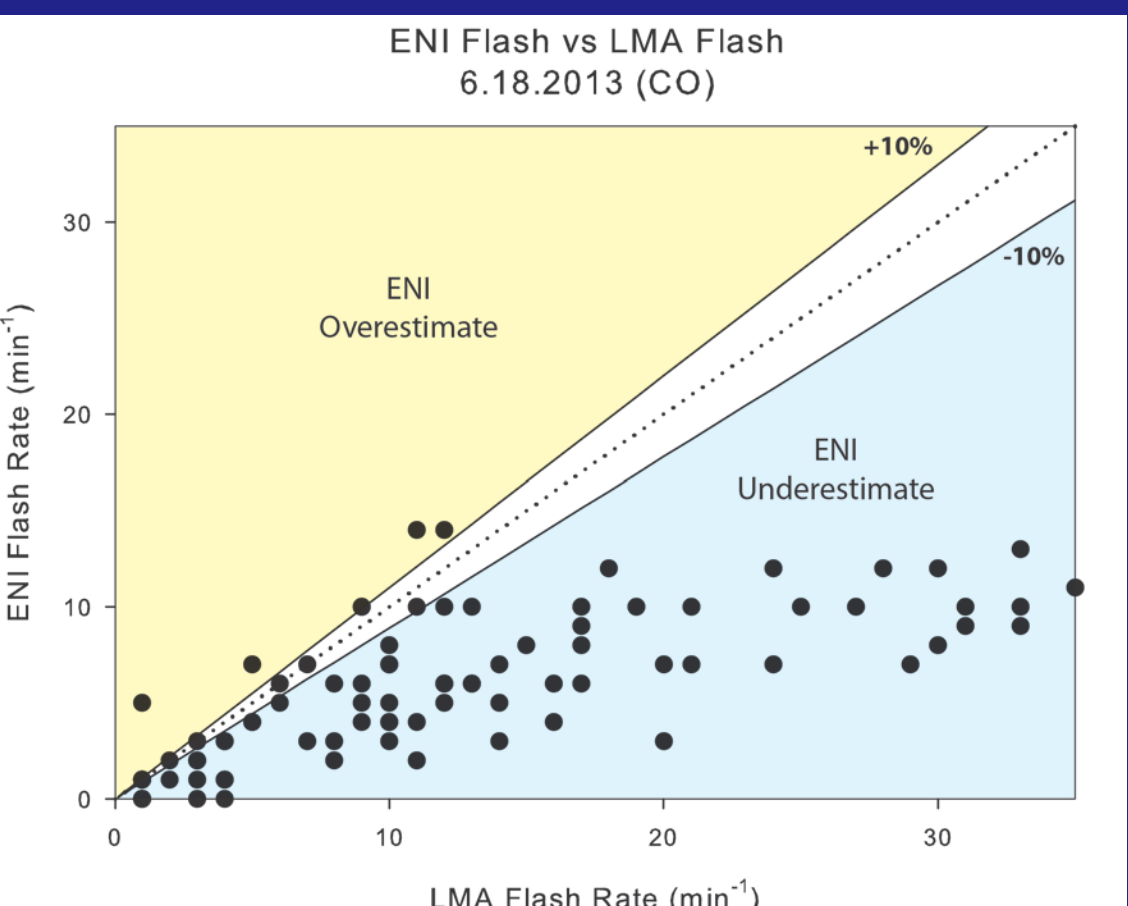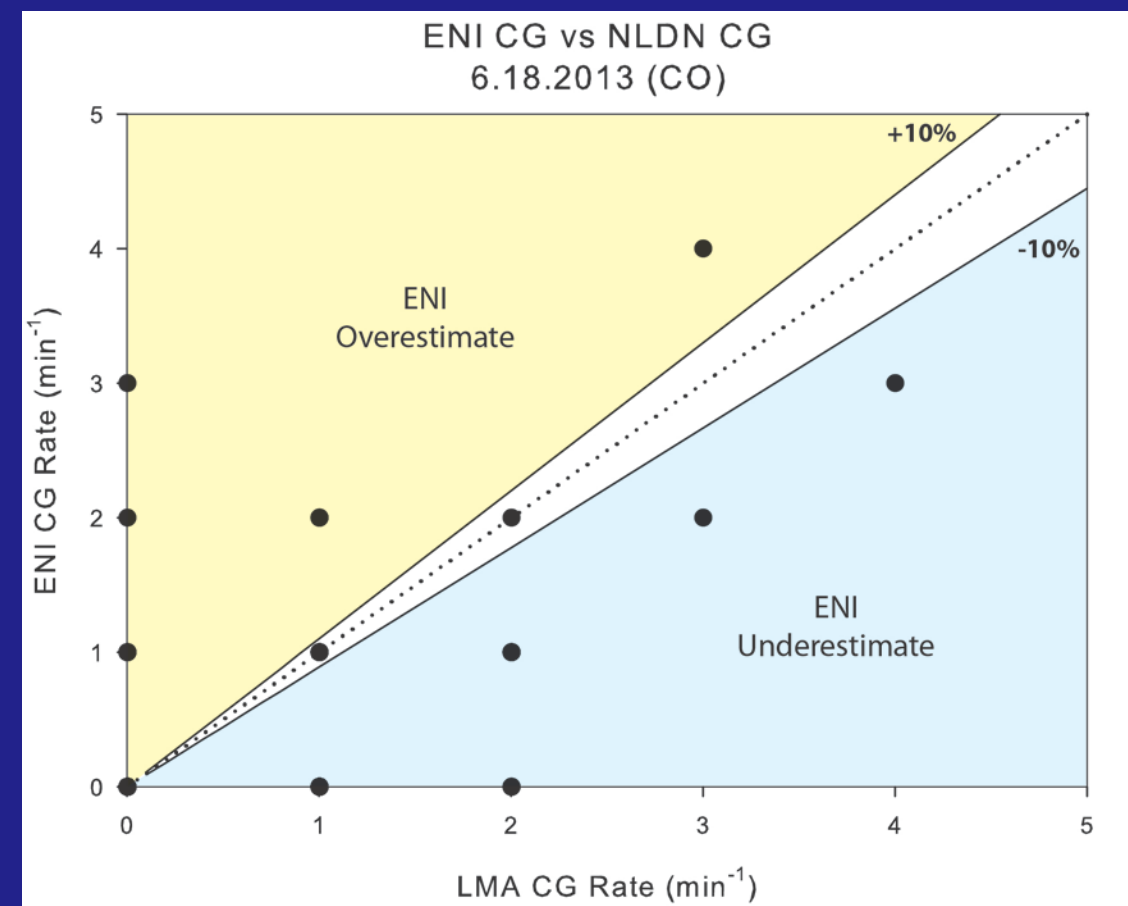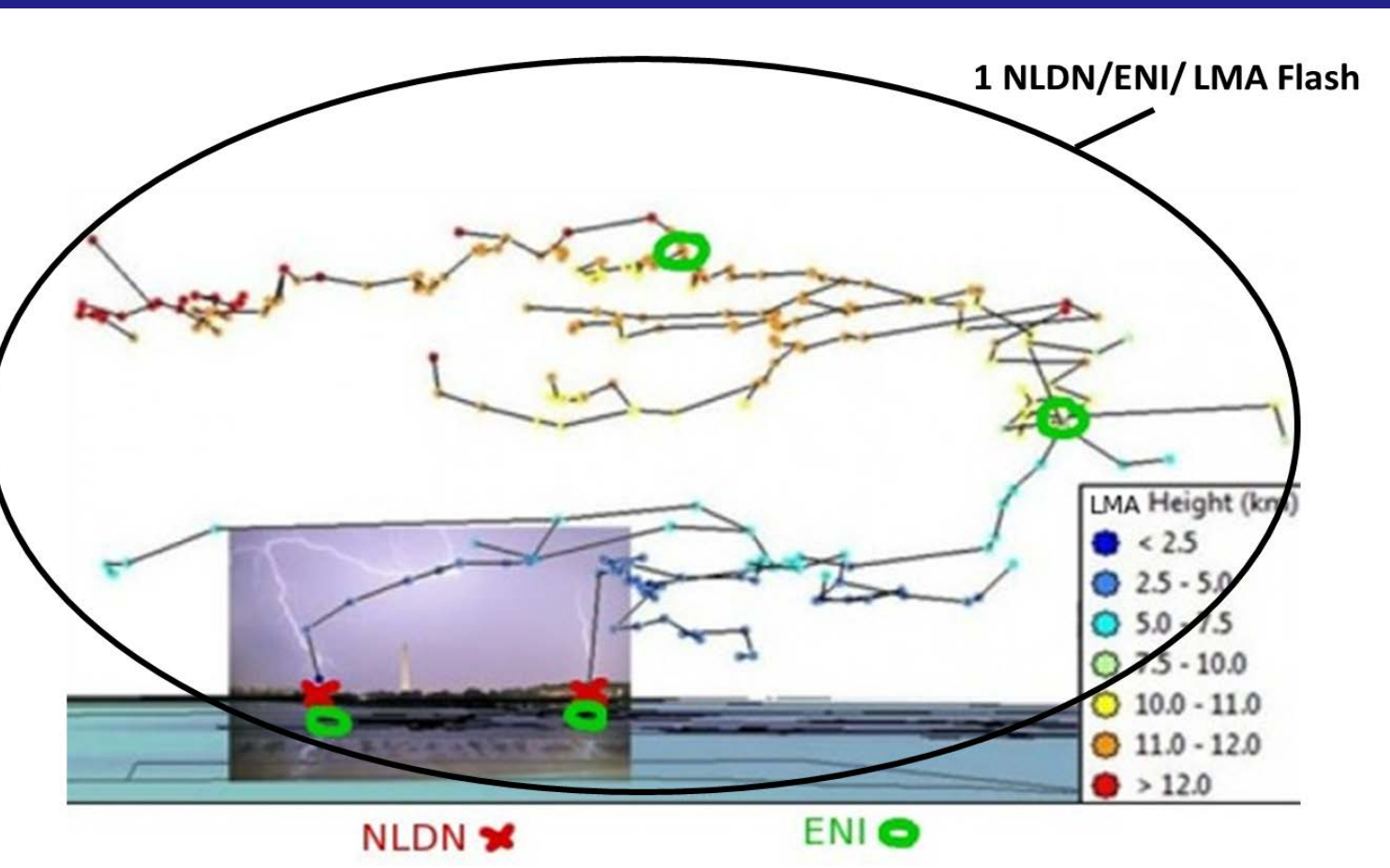
•LMA shows lightning jump before EF1 tornado
      •No ENI lightning jump
•ENI flashes underestimate LMA, especially for larger flash rates
•Overall small CG rates

3. LMA/NLDN/ENI CASES

ENI Flash vs LMA Flash 4.11.2013 (TN)

•Discrete storm SW of Nashville, TN
•North Alabama LMA
•Severe warning issued
•Non-severe hail report

ENI Flash vs LMA Flash 4.11.2013 (TN)

KOHX 16:32 UTC

ENI CG vs NLDN CG 4.11.2013 (TN)
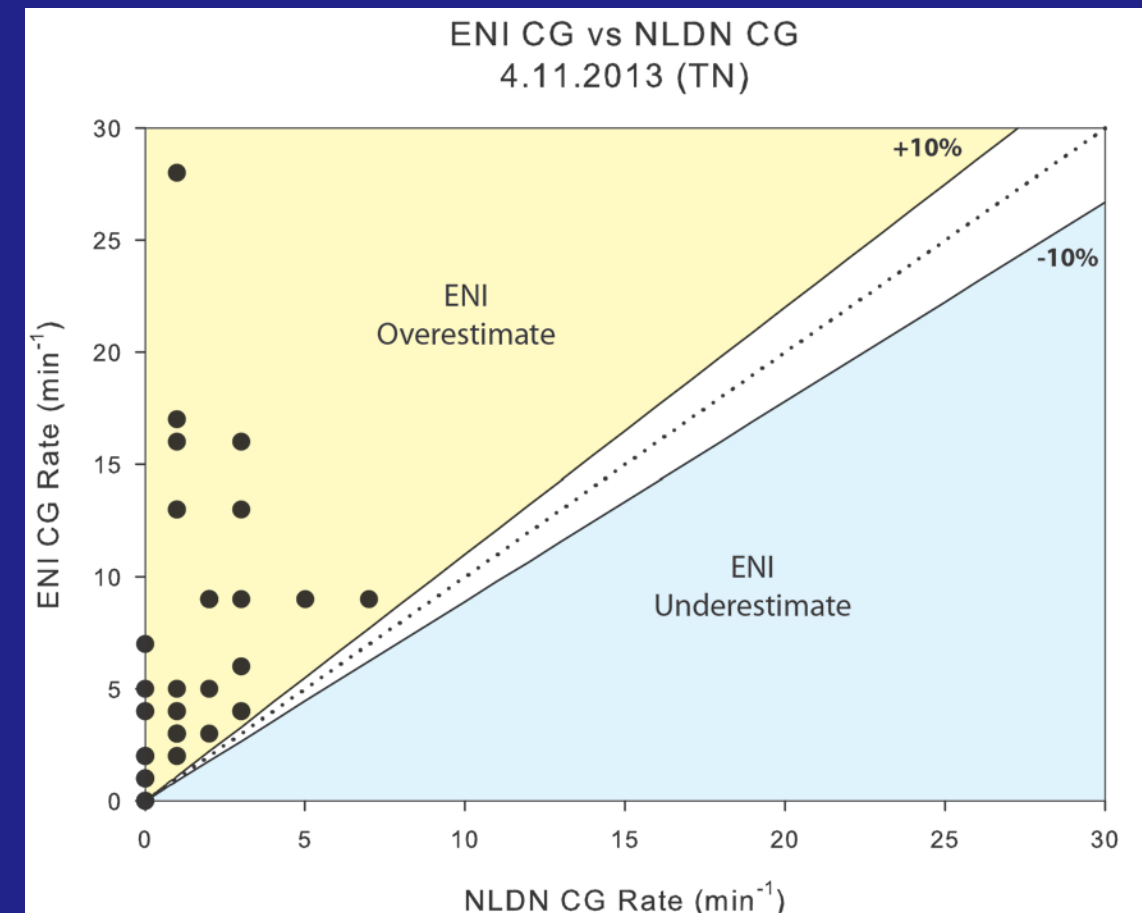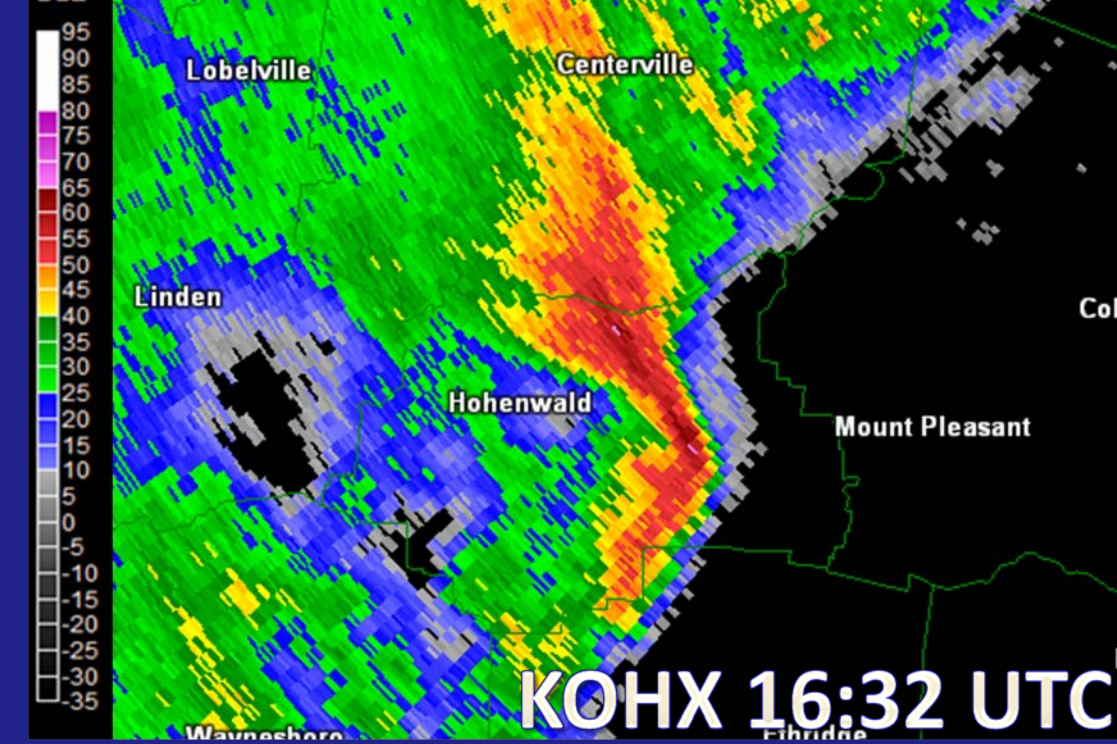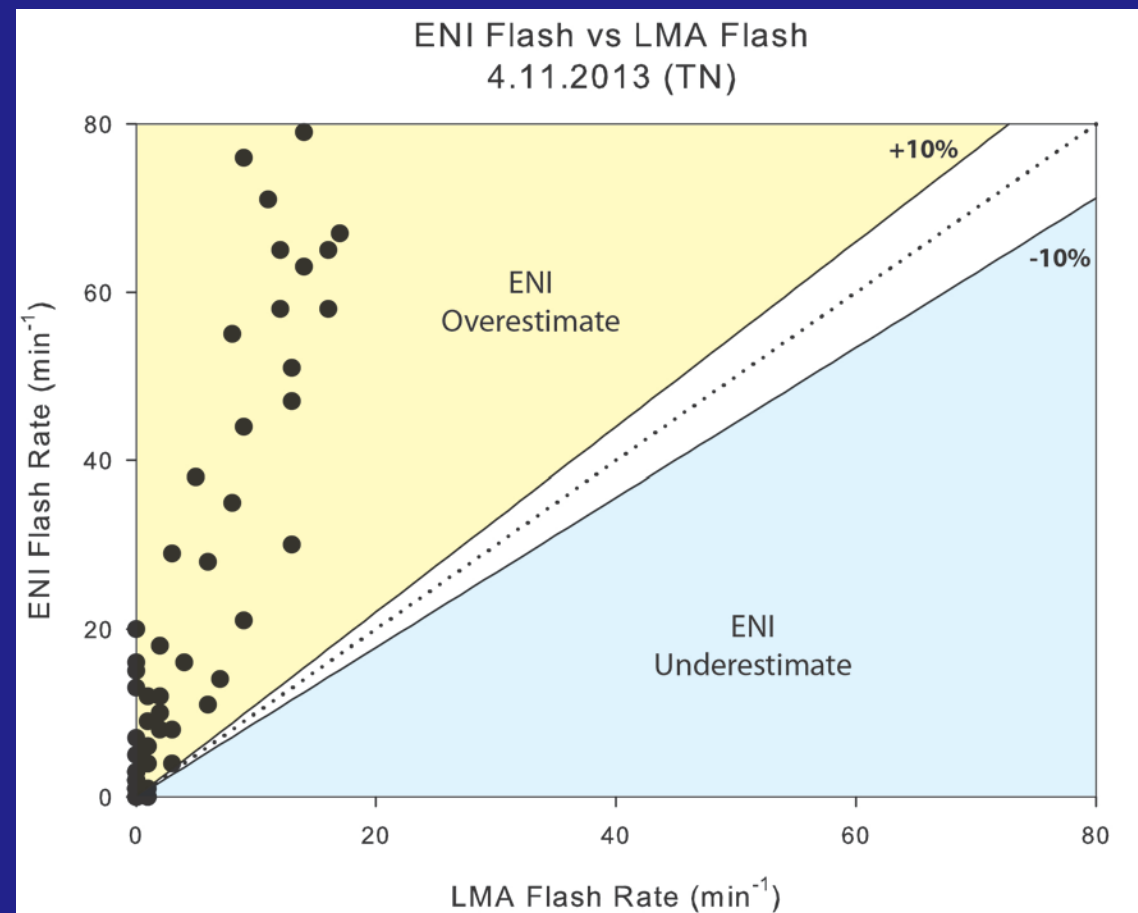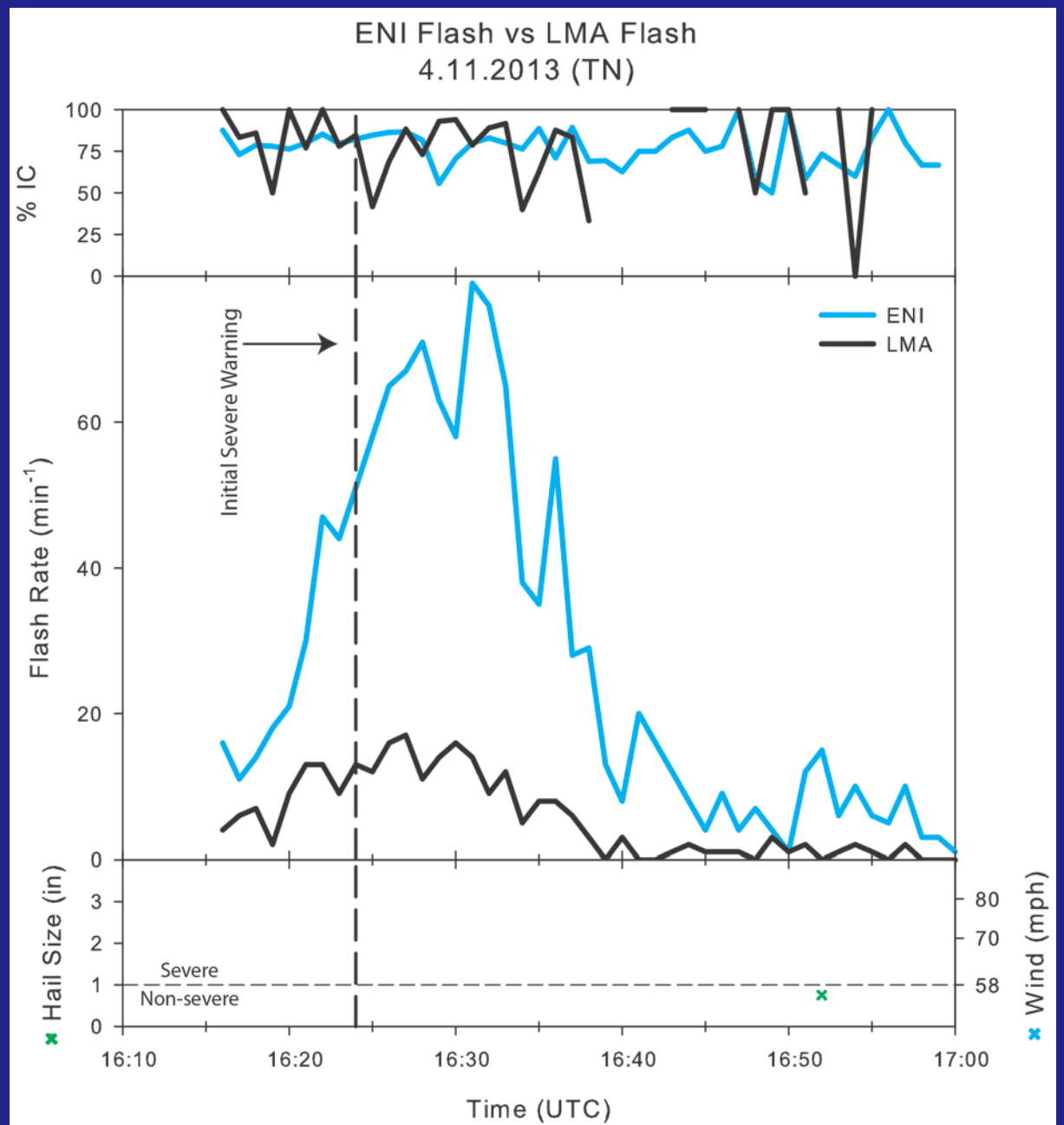
•ENI data suggests lightning jump, but not present in LMA data (no severe reports)
•ENI flashes greatly overestimate LMA
•ENI CG Flashes overestimate NLDN CG flashes

ENI Flash vs LMA Flash 4.30.2013 (TX)

•High based storm NW of Lubbock, TX
•West Texas LMA
•Severe warning issued
•Non-severe wind report

ENI Flash vs LMA Flash 4.30.2013 (TX)

KLUB 00:07 UTC

ENI CG vs NLDN CG 4.30.2013 (TX)
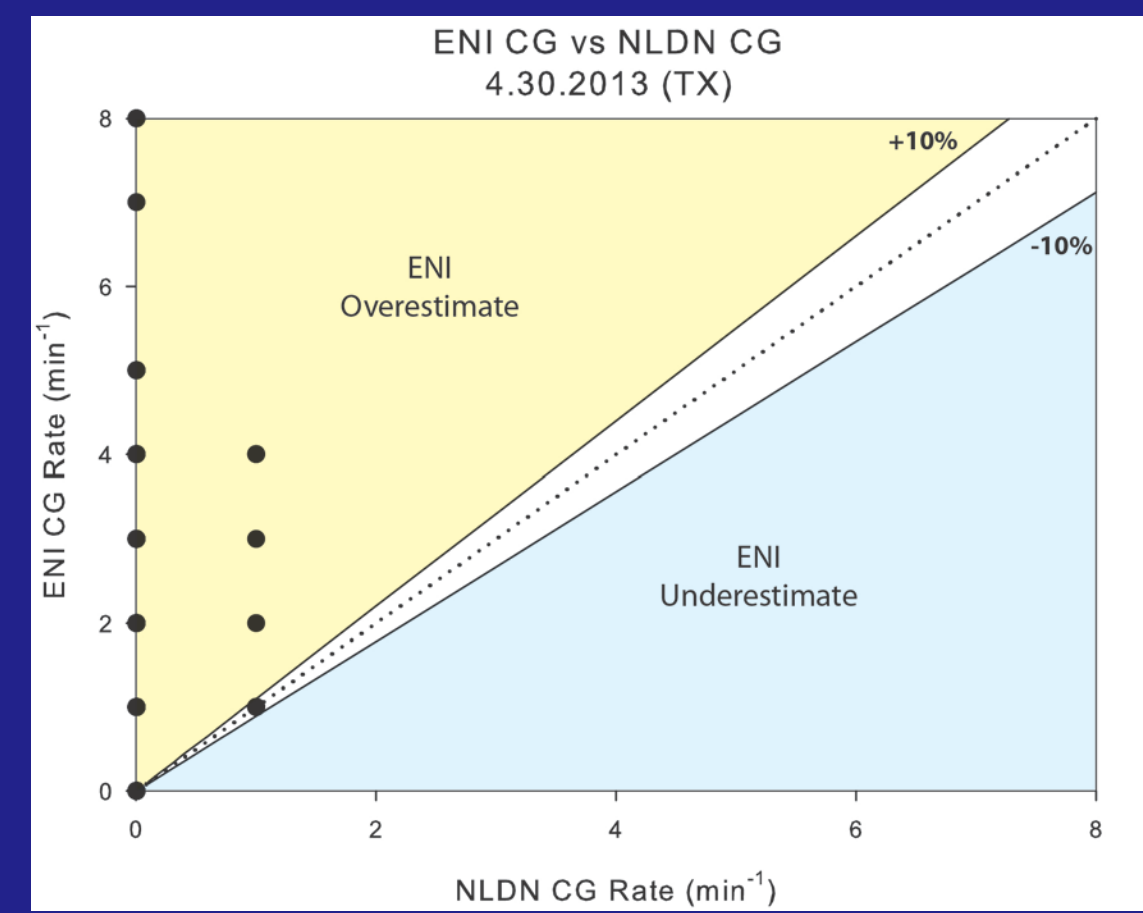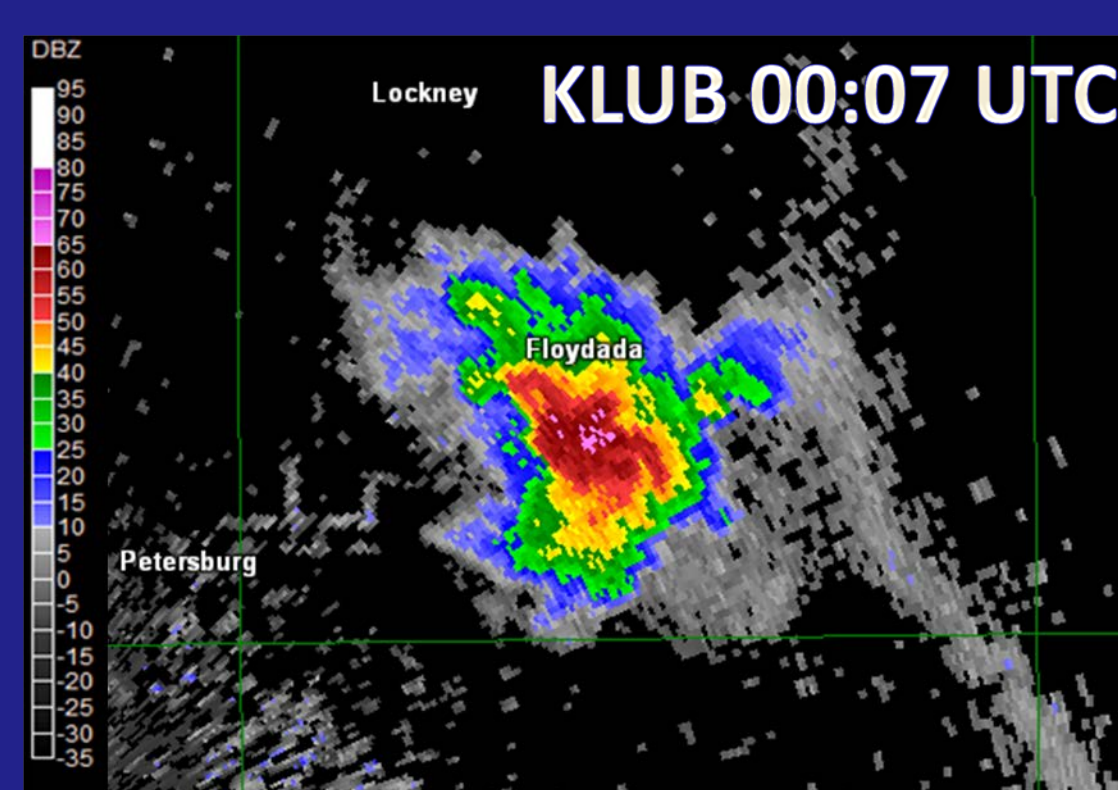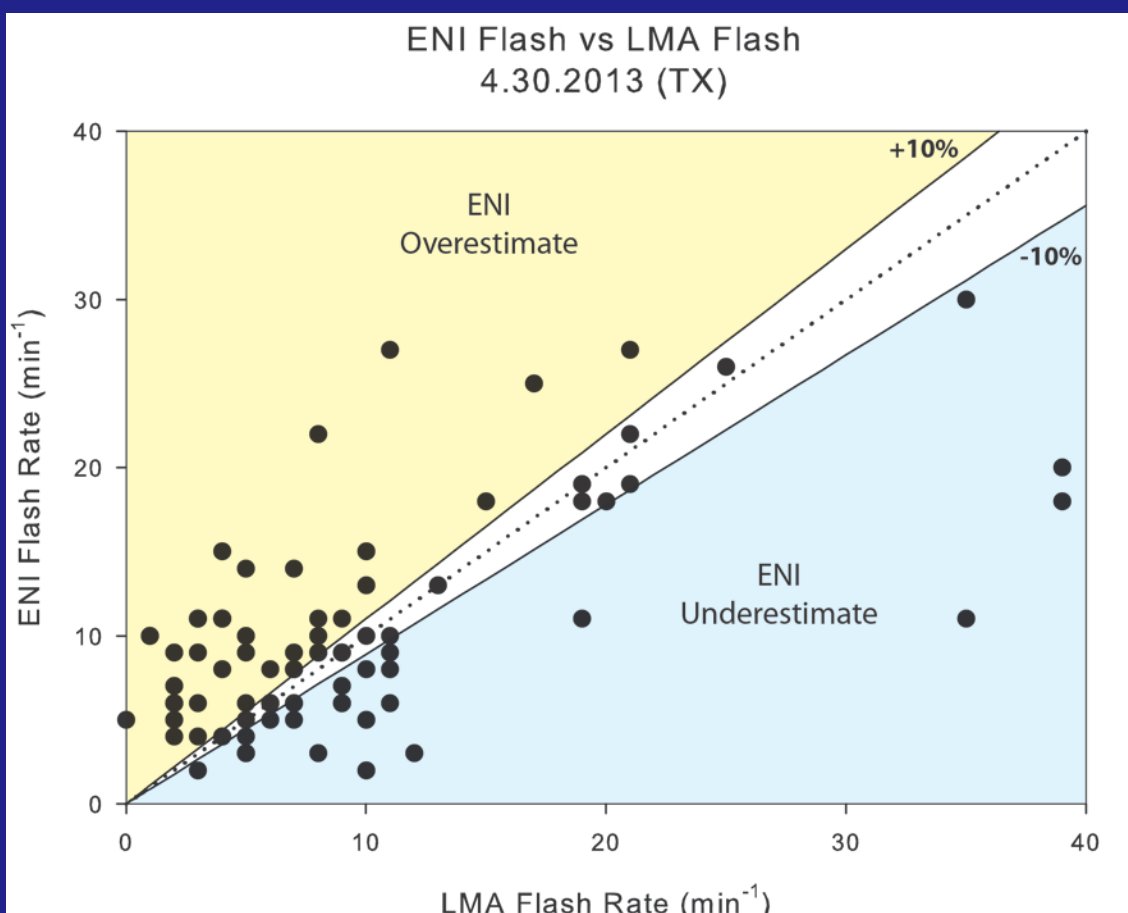
•Same general trend of ENI and LMA flashes
      •Lightning jump present in both ENI and LMA data-sub-severe wind report 25 min after
•ENI IC percentage less than LMA
•ENI CG flashes greatly overestimate NLDN CG flashes

ENI Flash vs LMA Flash 6.18.2013 (CO)

•Tornadic supercell near Denver, CO Airport
•Colorado LMA
•Tornado warning
•EF1 tornado

KFTG 20:19 UTC
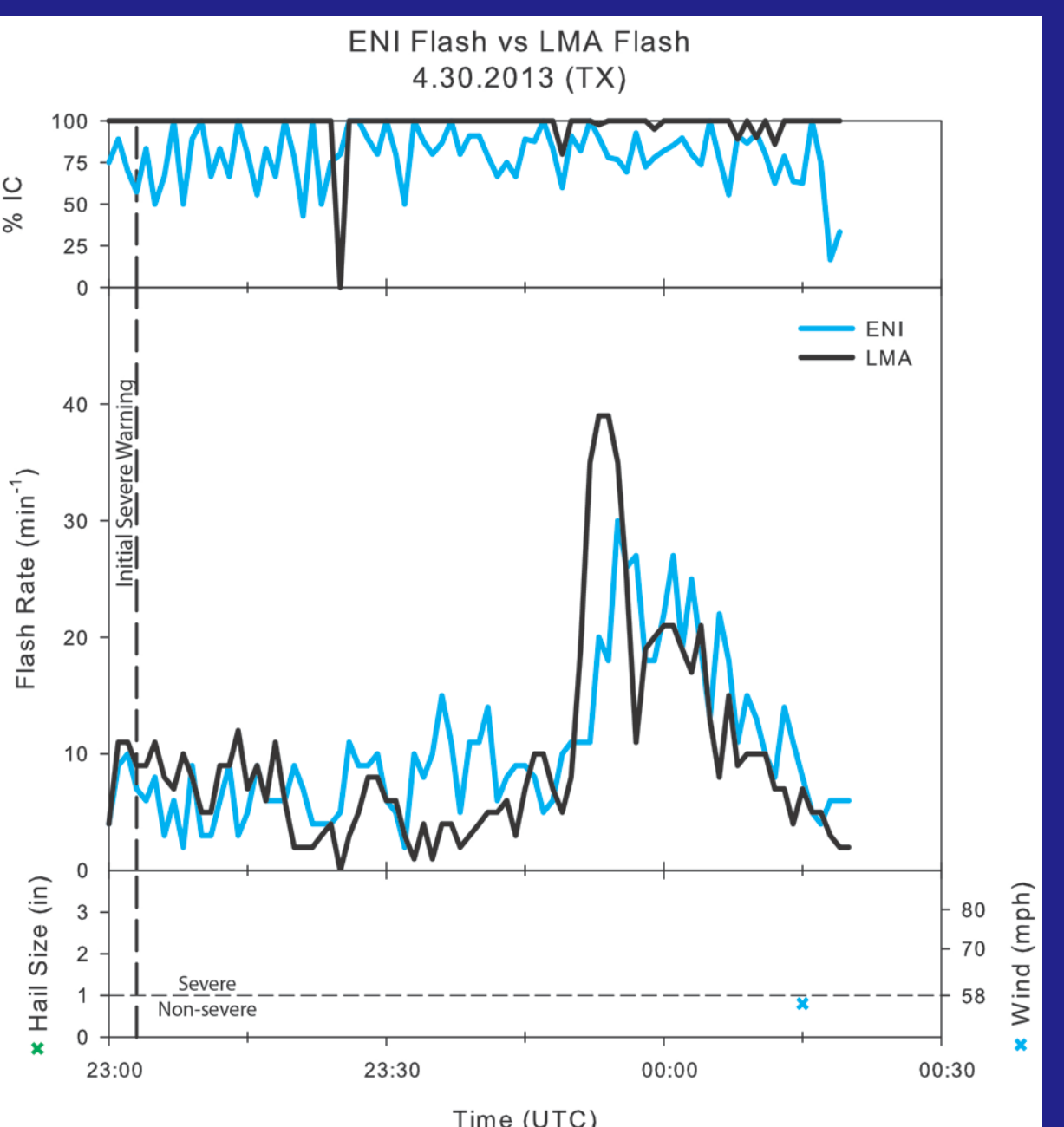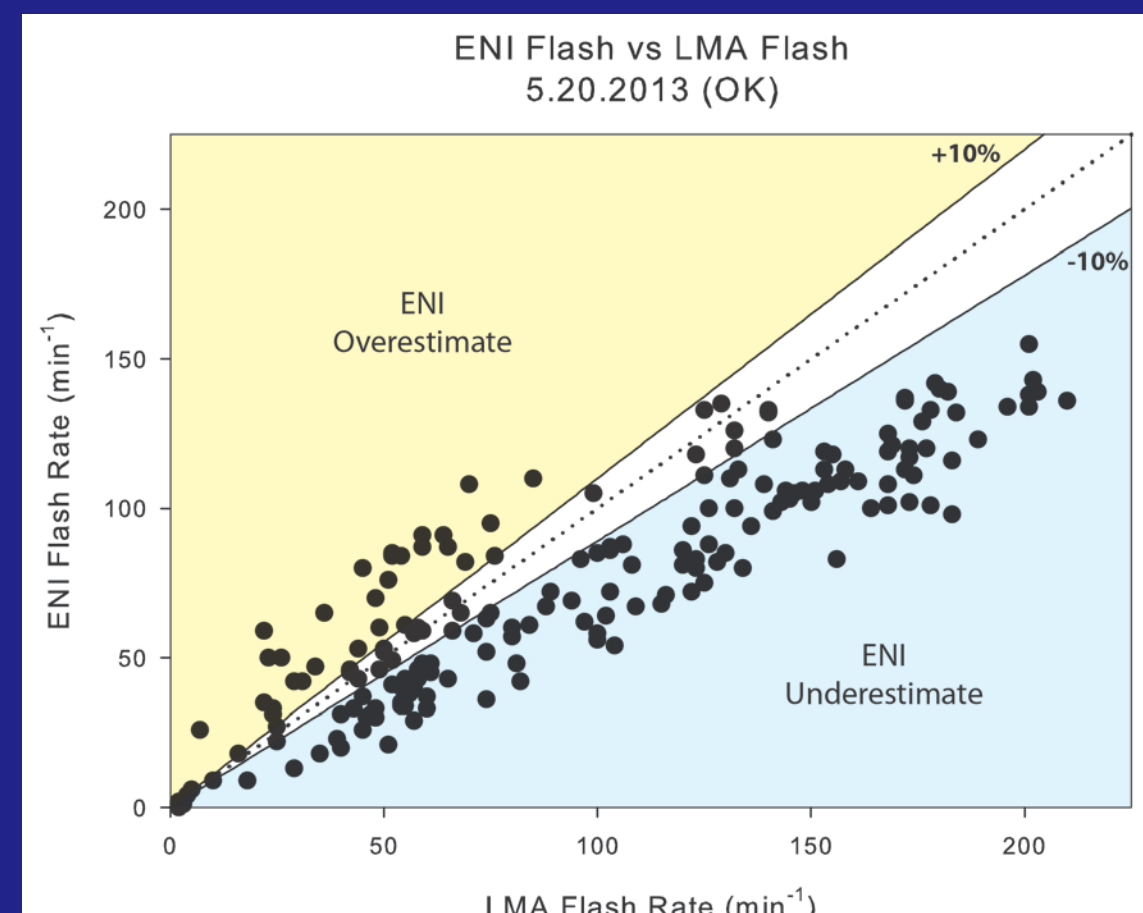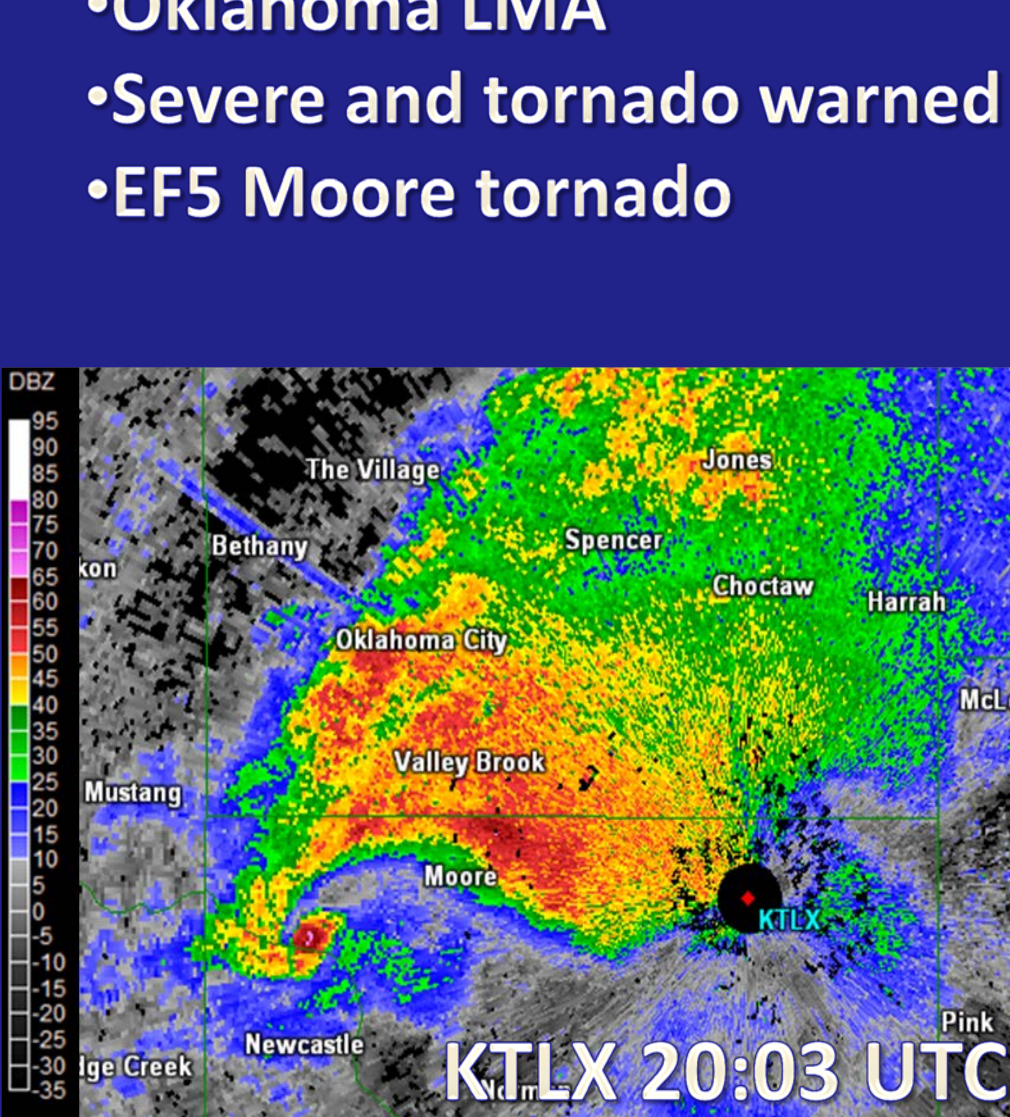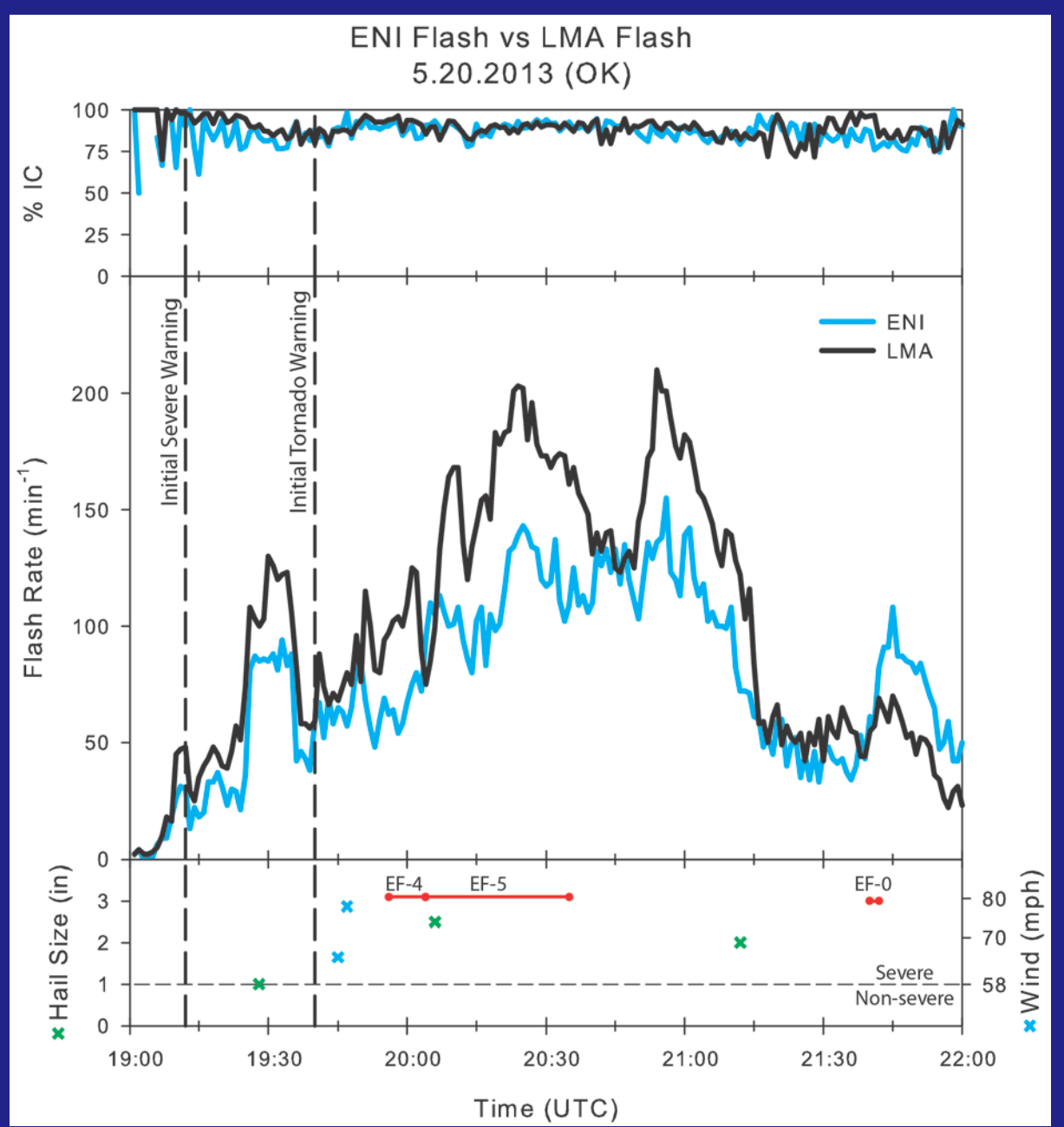
ENI Flash vs LMA Flash 5.20.2013 (OK)

•Tornadic supercell in Moore, OK
•Oklahoma LMA
•Severe and tornado warned
•EF5 Moore tornado

ENI Flash vs LMA Flash 5.20.2013 (OK)

KTLX 20:03 UTC

•Overall trend of ENI and LMA data is very comparable
•Lightning jumps present in both ENI and LMA prior to tornado and severe hail/wind reports
•ENI flashes underestimate LMA throughout storm-especially for larger flash rates
•ENI CG Flashes slightly overestimate lower NLDN CG flash rates

ENI CG vs NLDN CG 5.20.2013 (OK)
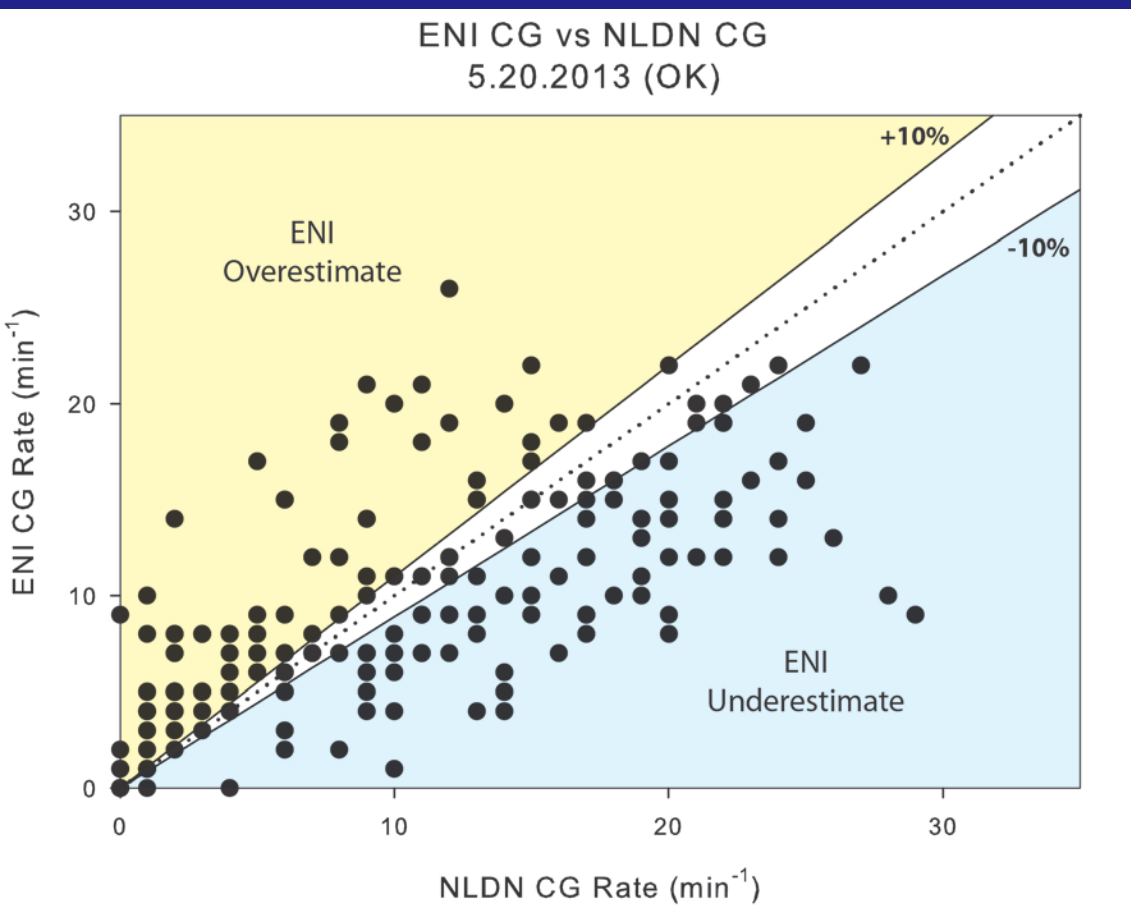
ENI vs LMA Storm Statistics

Date	Time (UTC)	State	ENI IC %	LMA IC %	ENI Flash DE (%)	ENI IC DE (%)	ENI CG DE (%)
*5.23.2011	20:35-00:15	OK	96.0	98.6	35.3	34.4	98.2
*5.24.2011	19:00-21:50	OK	95.5	88.8	112.7	121.2	45.2
4.11.2013	16:15-18:00	TN	77.7	74.6	476.5	496.4	417.9
4.30.2013	23:00-00:20	TX	79.9	99.1	108.1	87.2	2371.4
5.20.2013	19:00-22:05	OK	86.8	88.7	78.4	76.7	92.3
6.18.2013	19:45-21:30	CO	92.0	95.0	47.0	45.5	75.5
Average			88.0	90.8			*Not shown

•ENI and LMA IC% similar
•Variable DE for ENI-even within same location

4. ENI/NLDN CASES

KMSX 20:40 UTC

ENI CG vs NLDN CG 5.13.2013 (ID/MT)
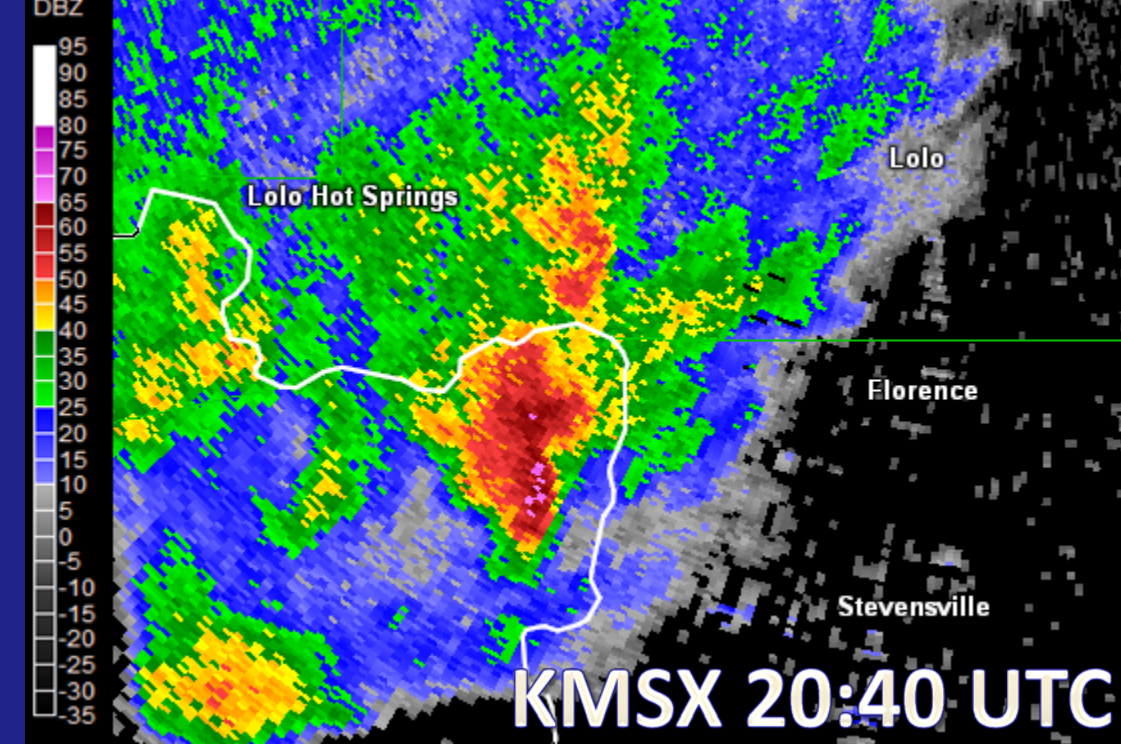
•Multicell in ID/MT
•Severe warning but no reports

•ENI CG flashes overestimate NLDN CG flashes

KFDX 00:15 UTC

ENI CG vs NLDN CG 5.06.2013 (NM)
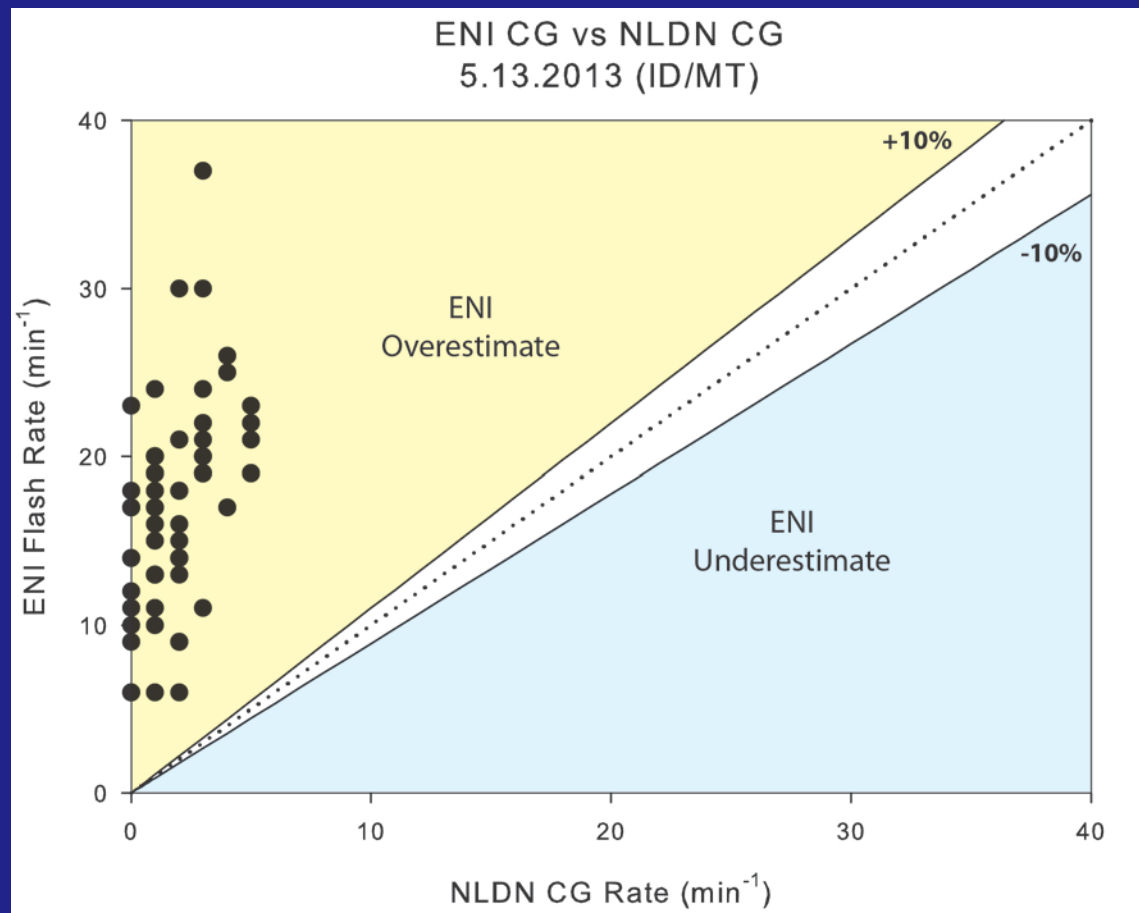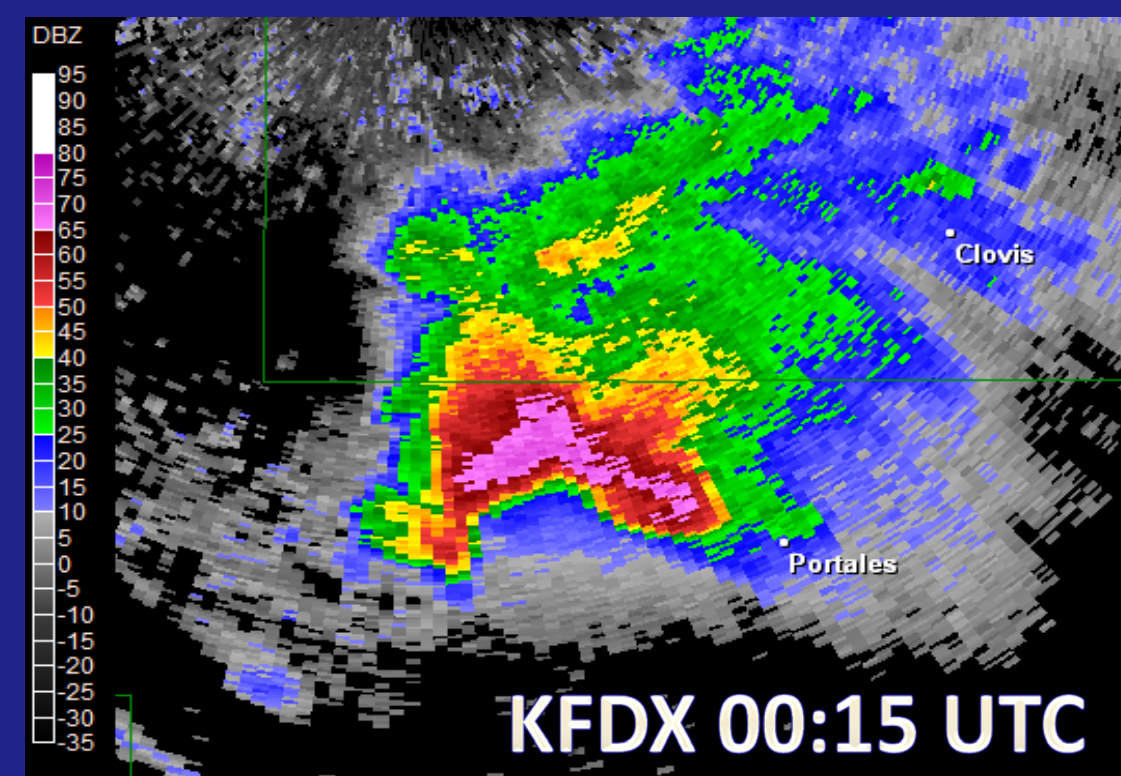
•Supercell in NM
•Severe reports (1" hail)/warnings
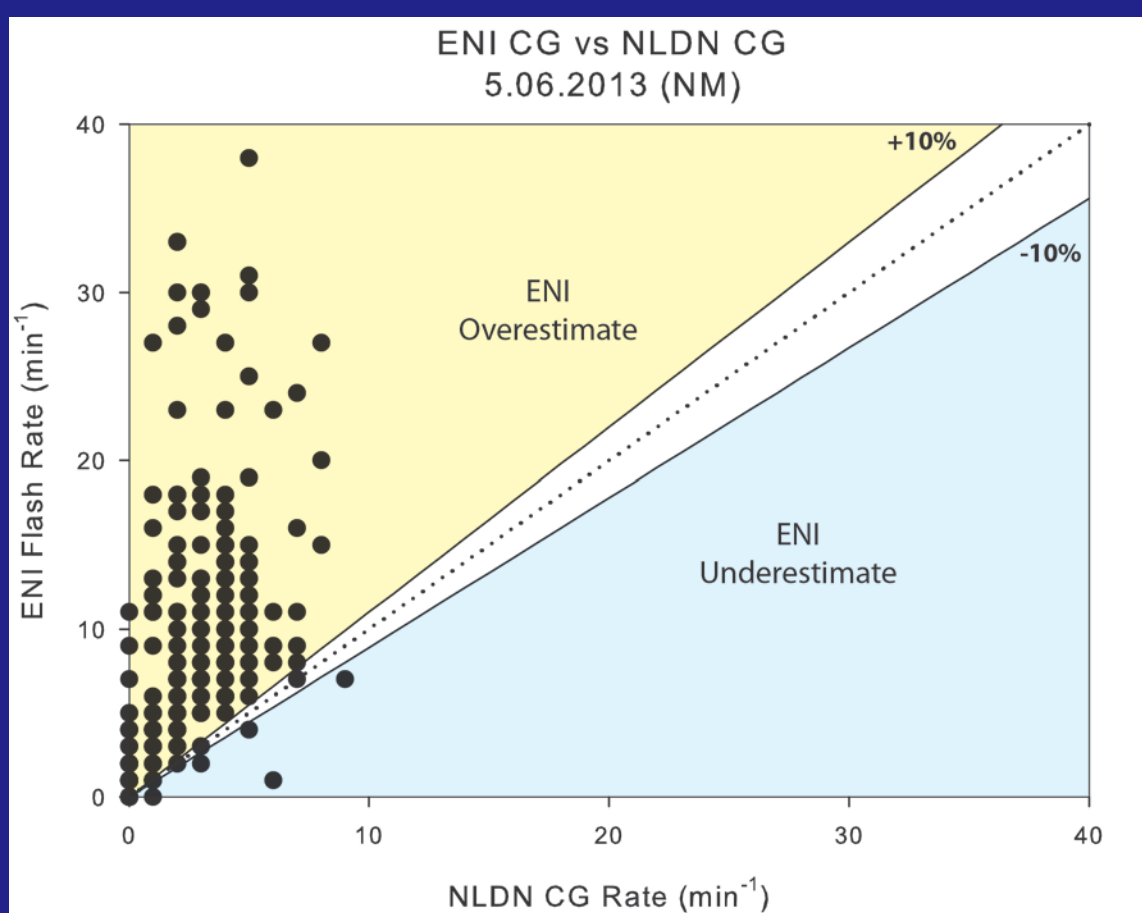
•ENI CG flashes greatly overestimate NLDN CG flashes

4. CONCLUSIONS/FUTURE WORK

| Strengths	Weaknesses
Earth Networks	
Detects total lightning (IC and CG)	Constantly adding/updating sensors
CONUS (and world) wide detection	Widely variable DE throughout US
	Over/underestimate of CG flashes
Lightning Mapping Array	
~100% DE for total lightning (IC and CG)	Limited areal coverage
Reliable height information	
National Lightning Detection Network	
Currently improving sensors to 50% IC DE	Only CG flash lightning available
Consistent 95%+ CG DE throughout US	

Best Practices:

•Beware of the strengths and weaknesses of each lightning network
•For ENI be aware of DE in your area since highly variable
•Don't rely only on total lightning for severe warning decision making
•When NLDN CG flash rates are less than 10, ENI greatly overestimates
      •Higher the NLDN CG rates, ENI underestimates

Questions brought up:
•Why such a discrepancy between NLDN CG and ENI CG at times?
•How exactly are ENI's flashes/pulses grouped as CG's or IC's

Future work:
•More cases:
      •updated ENI CG algorithm
      •updated NLDN IC detection
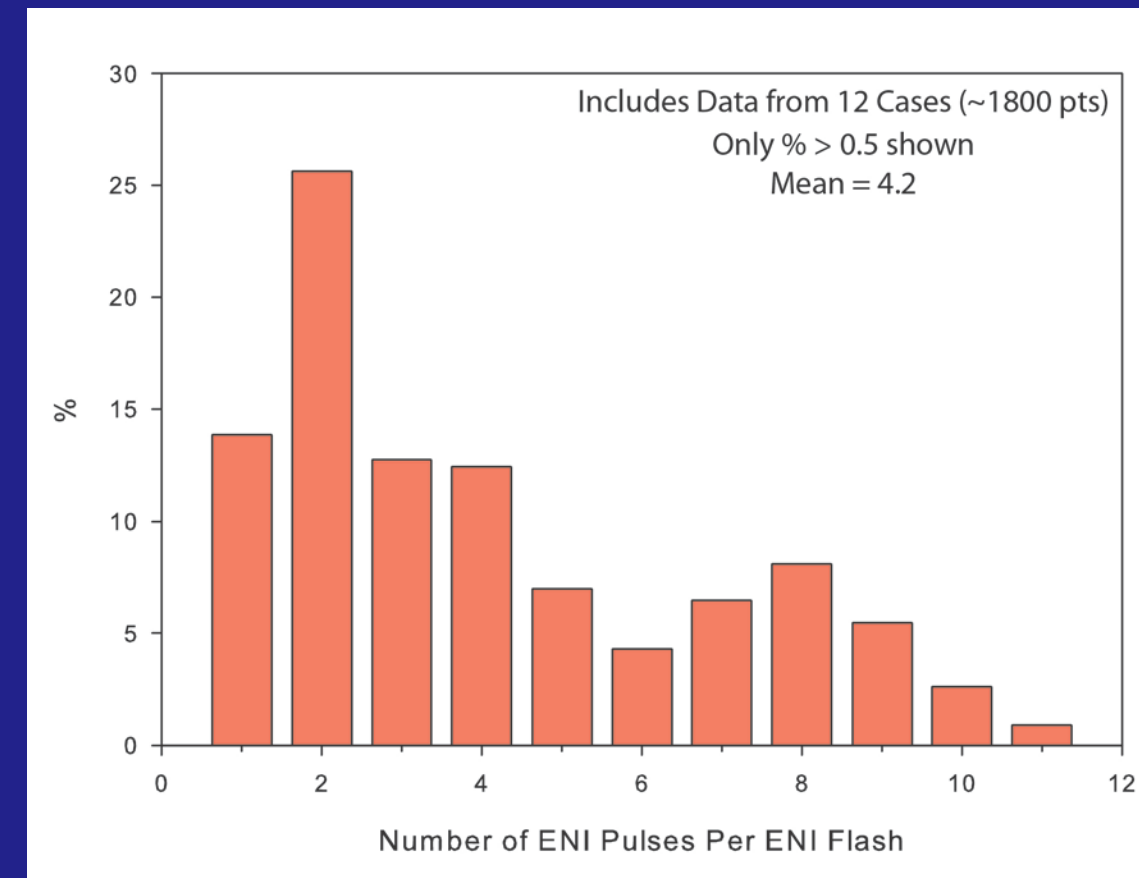
•Overall low number of ENI pulses per flash